# Integrating cavities and UV water absorption

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One of the most sensitive techniques for measuring a very weak spectral absorption is based on an integrating cavity. An integrating cavity is a closed container whose wall is a diffuse (Lambertian) reflector with a very high reflectivity. When a sample is placed in an integrating cavity, the result of the multiple reflections of the light from the cavity walls is that the light makes many transits through the sample, i.e., the effective path length through the sample far exceeds the dimensions of the sample. For example, the effective path length through a sample that fills a spherical cavity of radius 7.5 cm is about 100 meters if the wall reflectivity is 99.9%. The result is a very high sensitivity to a very weak absorption. In addition, since the diffuse reflecting walls of the cavity produce an isotropic illumination of the sample, absorption measurements are not affected by light scattering in the sample.

We have developed a new diffuse reflecting material that has significantly higher diffuse reflectivity in the visible than that of the best previous existing material known as Spectralon (e.g., we have obtained a 99.92% diffuse reflectivity at 532 nm versus 99.4% for Spectralon). In addition, this new diffuse reflector has a reflectivity that exceeds 99.6% at wavelengths down to 250 nm. This new material is opening new research vistas by providing very sensitive and accurate direct spectral absorption measurements of both a sample and any particulates suspended in it. As important examples we have obtained the first accurate measurements of pure water absorption in the near UV [1], and we have demonstrated the capability to measure for the first time the very weak spectral absorption of highly scattering biological samples [2].

## References

[1] Mason, J. D., Cone, M. T., and Fry, E. S., 2016: Ultraviolet (250–550 nm) absorption spectrum of pure water. *Appl. Opt.* **55**, 7163–7172.

[2] Cone, M. T., Mason, J. D., Figueroa, E., Hokr, B. H., Bixler, J. N., Castellanos, C. C., Wigle, J. C., Noojin, G. D., Rockwell, B. A., Yakovlev, V V., Fry, E. S., 2015: Measuring the absorption coefficient of biological materials using integrating cavity ring-down spectroscopy. *Optica* **2**,162–168.